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High Protein Wheat Production

Canadian hard red and durum wheats have long been recognized as premium quality grains by the milling and pasta industries. This quality is mostly attributed to the protein constituent. The protein premiums offered on these classes of wheat show how each increase in protein level leads to better returns for the producer (Table 1).

Table 1. 1996/97 and 1995/96 Initial payments for CWRS* and CWAD* (in store Thunder Bay or Vancouver)

Grade	$/BU 96/97	$/BU 95/96
#1CWRS 14.0	5.55	7.27
#1CWRS 13.0	5.33	6.94
#1CWRS 12.0	5.23	6.78
#1CWRS	5.17	6.70
#1CWAD 13.5	5.01	8.87
#1CWAD 13.0	4.87	8.65
#1CWAD 12.5	4.68	7.48
#1CWAD	4.63	7.10

*CWRS = Canadian Western Red Spring Wheat
*CWAD = Canadian Western Amber Durum Wheat

Protein premium incentives lead producers to ask two questions:

1. Can the protein content of wheat be increased with appropriate management?
2. Is it economical to fertilize wheat with additional nitrogen (N) to obtain a protein premium?

An understanding of the factors that influence protein content is needed to address these questions.

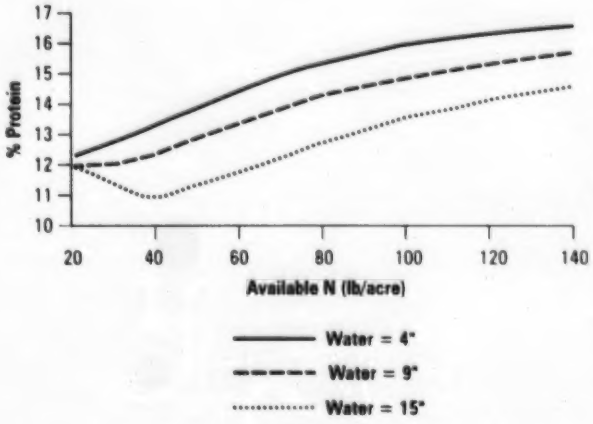
Factors affecting protein content

Environmental conditions

Several major factors influence protein content:

- timing and amount of growing season precipitation
- temperature and heat (degree days) during the growing season
- soil nitrogen reserve levels (mineralization throughout the growing season will add to available nitrogen)
- applied nitrogen fertilizer (pre-plant, at seeding and in crop applications)

Weather during the growing season is the overriding factor in determining protein content. It controls two of the major factors influencing protein content: the timing and amount of growing season precipitation and the degree days. However, there are interactions between the weather and the controllable variable, nitrogen. Figures 1 and 2 help illustrate this relationship.



Source: *Selles, Agriculture and Agri-Food Canada, Swift Current*
Available N is soil N plus fertilizer N. Water is soil water plus May 1 to July 31 precipitation.

Figure 1. Effect of water and nitrogen on protein content

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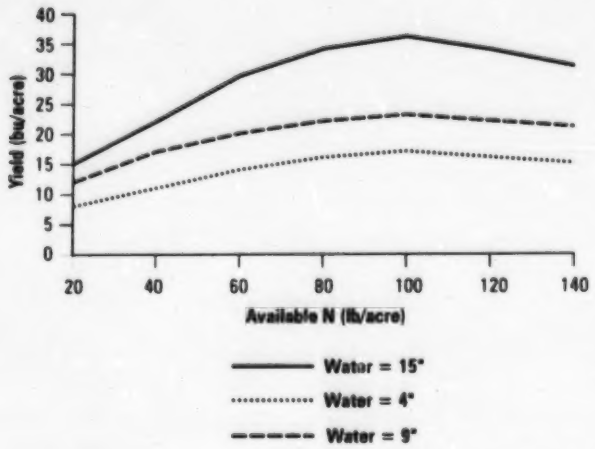

Source: *Selles, Agriculture and Agri-Food Canada, Swift Current*
Available N is soil N plus fertilizer N. Water is soil water at seeding plus May 1 to July 31 precipitation.

Figure 2. Effect of water and nitrogen on yield

In dry years, when yield response to available nitrogen (N) is low, the nitrogen goes to increased protein production in grain. In wet years, nitrogen goes to increase wheat yields. If additional nitrogen fertilizer is added, protein levels can actually increase. If there is insufficient nitrogen, the result is a large increase in starch production (the main constituent of yield) relative to the available nitrogen (which is required for protein synthesis). Consequently, the protein accumulation in the seed is low, and kernels may even appear piebald due to their high starch content.

In wet years with high yields, large additions of nitrogen fertilizer are often required to maintain or increase protein. The problem is that it is not possible to predict growing season moisture or temperature. Therefore, a high application of nitrogen at or prior to seeding to increase protein carries a high level of risk under dryland farming.

The timing of fertilizer applications can also be important in determining protein content. An adequate pre-plant application of nitrogen is essential to establishing yield potential. **However, nitrogen taken up by the plant after the boot stage (just before heading) contributes primarily to increased grain protein.** Therefore, the supply of nitrogen to the plant should be maintained through the boot stage to provide for optimum yield and protein potential.

Split applications of nitrogen, by applying a mid-season application at the boot stage, could be considered as a way to increase protein. With this approach, the risk of applying a single, high nitrogen application early in the season is reduced. The decision to apply further nitrogen can be made based on established crop potential and mid-season growing conditions.

There are risks associated with top-dressing nitrogen. Broadcasting ammonium nitrate (34-0-0) or dribble banding of liquid nitrogen requires moisture to move the nitrogen into the root zone. A mid-season drought can temporarily strand the nitrogen at the soil surface. Urea (46-0-0) fertilizer is not recommended for broadcast applications as volatilization losses into the air can be high.

Foliar application could also be used; however, rates of over 20 lbs/ac of nitrogen can lead to leaf burn and crop injury.

Slow release fertilizers and livestock manure have some potential in maintaining a sustained supply of available nitrogen over the growing season. Sulphur may also influence protein content. More research into this area is needed to determine the effectiveness for increasing grain protein under a range of growing conditions.

Soil testing to determine plant available nitrogen is the best way to decide on appropriate rates of nitrogen fertilizer application. Soil samples should be taken to 24 inches, and information provided by the soil analysis can be used in conjunction with nitrogen fertilizer cost, predicted grain yield and protein response to weigh the economic feasibility of nitrogen fertilizer application.

To help producers plan their fertilizer needs, Alberta Agriculture, Food and Rural Development has a new computer program called "AFFIRM." This software will give you an anticipated yield response to fertilizer after entering soil analysis results and other variables. The program can be downloaded from the department's "Ropin the Web" Internet site at http://www.agric.gov.ab.ca/soil/affirm.html. Producers can also discuss fertilizer requirements with Alberta Agriculture crop specialists.

Genetic potential of the wheat variety

Wheat varieties differ slightly in their ability to convert soil nitrogen to grain protein. Tables 2 and 3 illustrate the variation in grain protein levels of hard red spring and durum wheats respectively. Some higher protein varieties tend to have lower yield potential. Care should be taken when selecting varieties to consider both yield and protein potential as well as overall agronomic characteristics.

Table 2. Average protein content of selected CWRS wheat grown in regional variety trials in Saskatchewan in 1994 and 1995

Variety	% Protein
Katepwa	13.2
CDC Makwa	13.2
Pasqua	13.2
Invader	13.8
CDC Teal	13.8
AC Barrie	13.9
Roblin	13.9

Table 3. Average protein content of durum varieties grown in Western Canadian cooperative trials, 1986-1993

Sceptre	13.6%
Medora	14.0%
Plenty	14.0%
Kyle	14.3%

Economics

The economic feasibility of fertilizing for protein content can be determined by the protein premiums offered, the price of nitrogen fertilizer and the crop potential for increased protein. This crop potential will be determined by the growing season conditions, nitrogen availability and the chosen variety.

Research on the economics of fertilizing for protein premiums is currently underway in Alberta. Several more years of data need to be collected on a province-wide basis before conclusions can be drawn on this topic.

Summary

Protein content of wheat can be increased with appropriate management. The following is a brief summary of some of the necessary management tools:

1. Select a well adapted variety with high protein potential.
2. Take soil samples to 24 inches to make an informed decision on fertilizer rates.
3. Consider soil available moisture at planting and average precipitation for the area to help determine yield potential and risk levels of nitrogen application for protein premiums. This consideration is especially true in areas of low growing season precipitation.
4. Split application of nitrogen. If it is a wet year, 15-30 lbs/ac of nitrogen (34-0-0) could be applied at the boot stage. Any nitrogen fertilizer application decisions should be made keeping the risks in mind. Remember that the weather during the growing season is the major overriding factor in determining protein levels.
5. Start on a small area. Try adding additional nitrogen during the growing season to only a small portion of your total wheat acres. This approach will keep your risk down to a minimum.

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